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The Philippine Agriculturist

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PHANAEROGAMIC ROOT PARASITES[1]

By D. A. Herbert
Of the Department of Plant Physiology.

Parasitism is more characteristic of the lower types of plant life than of phanaerogams, but nevertheless the number of dependent seed plants is large and the degree of parasitism exhibited by them varies enormously. Strictly speaking the term should be applied to those forms obtaining nourishment from other living plants or perhaps from plants of their own species and even from some other part of their own anatomy. In the case of the strangling figs (*Ficus* spp.), the plant sends down a long root to the ground and becomes established. In the course of time it grows to such an extent that the host plant is strangled, dies, and finally decays leaving no indications of the fig's epiphytic origin. This killing of the tree on which it germinated is commonly spoken of as parasitism but strictly speaking is nothing of the kind as the fig derives no nourishment from its living host.

In cases of undoubted parasitism definite haustoria are produced except in the extreme case of *Rafflesia* where the vegetative organs of the parasite are all internal to the host (1). In the case of the Loranthaceæ the parasitic nature of the plant is obvious, but where the haustoria are subterranean i. e., in cases of root parasitism there is generally little indication that the plant is at all dependent on other living plants for any of its food material. Some indeed show leaf reduction, e. g., *Bartsia*, which is parasitic on the roots of grasses, but this cannot be regarded as any indication as it is also exhibited by holophytes such as *Casuarina* and numerous plants growing in arid or saline habitats. The proof of the existence of root parasitism lies in the discovery of the haustoria.

One of the most important plants investigated is the Sandalwood (*Santalum album*) the cultivation of which is an important industry in India. Barber (2) and others working in India showed that it was an obligate parasite and without a host plant cannot continue to exist. Closely allied to this is the Australian Sandalwood, *Fusanus spicatus*, R. Br. (*Santalum cygnorum*, Miq.), the wood of which is very similar to that of the Indian Sandalwood and which has now largely replaced the latter species in the Chinese market. The close chemical and taxonomic affinities of the two made it a point of interest to determine whether it too was parasitic. Investigation proved that this was the case (3).

[1] Experiment station contribution No. 192.

Further work (4) on another species of *Fusanus, F. acuminatus,* the Quandong, showed that it shared this characteristic with *F. spicatus* and *Santalum album.*

The haustoria on these three species are very similar. They arise laterally *from a root in contact with another root* either foreign or of the same species. The young haustorium at first consists of a parenchymatous outgrowth which rapidly enlarges forming a club-shaped organ. The cells in contact with the host have a marked power of destroying and absorbing its tissues, even the outer cork layers. The absorptive cells are rather smaller than the cells of the upper part of the cortex of the haustorium and divide rapidly pushing in and absorbing the tissues of the cork, cortex, phloem, and even some of the incompletely lignified wood elements. When the wood is reached the "sinker" as the invading tongue of tissue might be termed by analogy with the absorptive organs of *Viscum* and other Loranthaceæ, does not penetrate any further, but spreads laterally pushing aside the cortex to a certain extent as its margins grow. The cells of the upper part of the haustorium (the part external of the host root), have meantime been dividing and have produced a caplike structure. The cap acts as a protection for the sinker, but beyond this is of little use except in case of *Leptomeria preissiana* where it also serves as a place for the deposit of waste materials such as calcium oxalate.

The main points for consideration are whether the haustoria are modified roots and whether they are produced in the absence of host plants or whether they need contact of chemical stimulus before they are produced. It is not the purpose of this paper to go into a detailed account of the morphology of the parasitism of these plants, but investigation of all the available species of Santalaceæ in Western Australia (unpublished) in 1920 and 1921 and of *Olax imbricata* (5) on Mount Maquiling in 1922 showed that in no case was a haustorium produced at the end of roots. They were always produced laterally. If they had been produced terminally they might be regarded as modified root tips but their lateral origin and their peculiar structure mark them as organs as distinct from roots as the roots themselves are from stems. Cannon, however, working on *Krameria canescens* (Krameriaceæ) found that they are sometimes produced terminally. In the eight species examined, *Fusanus spicatus, Fusanus acuminatus, Exocarpus spartea, Exocarpus aphylla, Leptomeria preissiana,* and *Leptomeria spinosa* (Santalaceæ) and *Olax imbricata* (Olacaceæ), though several thousand haustoria were examined none were terminal. Numbers of them were apparently terminal owing to the fact that when their lateral haustoria become successfully attached the part of the root beyond them often dies and decays. The haustorium might then easily be mistaken for a terminal one. Examination with a hand lens however shows the scar of the decayed root.

Do phanaerogamic root parasites need contact or chemical stimulus before they produce haustoria? With some species the evidence indicates that they do, while in others that they do not. In the majority of such plants haustoria are produced only in contact with other roots, but generally the species is immaterial. *Santalum album, Fusanus spicatus, Fusanus acuminatus, Leptomeria preissiana, Exocarpus aphylla,* and *Olax imbricata,* have a wide range of hosts. The same applies to *Nuytsia floribunda* (6) the only known root parasite of the Loranthaceæ. (*Atkinsonia,* a terrestrial mistletoe found in the Blue Mountains of New South Wales has not yet been investigated). *Nuytsia* draws on ephemeral herbs for nourishment as well as on perennials.

Exocarpus spartea is a species which produces haustoria even in the absence of a host root, thus showing that a stimulus from a host plant is not necessary. In this it resembles *Loranthus philippinensis*, the most familiar of the Philippine mistletoes, which will sometimes form haustoria from its branches in the absence of a host. Very different is the case of *Leptomeria spinosa*. The parasitism of this species was investigated at Yoting, an agricultural district in Western Australia. Here there were a good many plants growing in the sand plain, and in each case they were accompanied by a low shrub, *Eremœa pilosa*. Parasitic attachments were found in each case on *Eremœa pilosa*, but no other species were attacked.

The results go to show that in the majority of cases there is no discrimination on the part of parasite, but that in some cases there is. In the latter case the chances of any particular plant of reaching maturity are small, for it may not find its host and must therefore die. Self-parasitism is common in seven of the species mentioned. It is often the simplest way of demonstrating the parasitic nature of the particular plant being investigated, as near the base of the plant the roots are fairly congested and generally some are in close contact with others. If self-parasitism takes place, as it does with most species it will be found there, and where self-parasitism takes place, parasitism on other species is always found. Investigation is needed in the case of families closely related to the Loranthaceæ and Olacaceæ to see whether it is restricted to particular families or whether it is a more or less general rule through families closely related to these two.

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THE RICE BORER (SCHŒNOBIUS INCERTELLUS WALKER)[1]

By Anastasio A. Rowan

WITH ONE PLATE

INTRODUCTION

The rice borer (*Schœnobius incertellus* Walker; Pyralidæ, Lepidoptera) is one of the worst enemies of rice in the Philippine Islands. In rice fields all over the Archipelago its attack is evident in the large number of whitened, empty panicles. Like many other serious pests, however, this particular species has been very little studied, and the farmers themselves, although undoubtedly conversant with the symptoms, generally attribute the damage to other than the actual causal agencies. In the province of Capiz, for instance, the following superstitious beliefs in regard to the appearance of the malady are current:

1. The west wind blows over the field while the rice is in flower. In the mountains between the provinces of Capiz and Antique stands a very poisonous tree that flowers during the rice season and its venom is scattered by the west wind over the rice fields below.
2. Lightning.
3. Attack of the rice bug (*Leptocorisa acuta* Thunberg).
4. Punitive acts of God or evil deeds brought about by forgotten deceased ancestors.
5. A corpse is carried past or through the rice field on its way to the cemetery.

The work of *Schœnobius incertellus* is characterized by a whitening of the entire panicle, including a large part of the contiguous distal portion of the stalk. On dissection it will be noted that the head has been severed from the rest of the plant by a *Schœnobius* larva which is lodged within the stalk. The attack of *S. incertellus* is distinguishable from that of *Leptocorisa acuta*, which it vaguely resembles, in that, in the case of the latter, there are only a few defective grains here and there in the head; there is rarely a case where the entire panicle is affected. The attacked grains, moreover, usually turn dark brown and a close examination reveals the puncture resulting from the insertion of the sucking mouth parts of the bug.

Schœnobius incertellus belongs to the family Pyralidæ. "Owing to the great difference between the male and the female, the sexes of this species have been described separately by several entomologists." Thus in 1863 the male was reported by Walker as *Chilo incertellus* and the female as *Tipanœa bipunctifera*. Later in the same year he redescribed the male of the same species as *Catagela* (?) *admotela* and the female as *Chilo gratiosellus*. Subsequently, within that year, Zeller described the male of this insect as *Schœnobius minutellus* and the female as *Schœnobius punctellus*. In 1896 Hampson described the male as *Schœnobius incertellus* and the female as *Schœnobius bipunctifer*. Shiraki, who was able to

[1] Thesis presented for graduation, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture, No. 160; Experiment Station contribution No. 193. Prepared in the Department of Entomology under the direction of Assistant Professor L. B. Uichanco.

compare the Japanese and the Formosan specimens with Walker's and Zeller's types in the British Museum, was positive in his statement that *bipunctifer* is the female of *incertellus*.

REVIEW OF PAST WORK

Except for a few scattered references in the literature, no published account about this pest has appeared in the Philippines up to the present time. These few references are included in general reports and in various special papers on other subjects pertaining to rice. Among the earlier authors who casually noted the damage done by this pest in the Philippines were Mackie (2), Gutierrez (3), Romero (4) and Camus (5).

In other countries, this pest has been more thoroughly studied. Leading the others in this respect is Formosa where Shiraki (1) has quite recently published a very creditable piece of work embodying an intensive series of investigations on *Schœnobius incertellus* for a period covering about six years.

The pest has also been studied, though on a less extensive scale, in Federated Malay States by Pratt (6), in Calcutta by Mackenna (7), in Assam by McSwiney (8), in Cochin China by Vincens (9), in Madras by Wood (10), in the Dutch East Indies by Hall (11), and in India, Burma, and Ceylon by Fletcher (12).

MATERIALS AND METHODS

Artificial breeding work in the laboratory was conducted by confining moths in cages, a pair consisting of a male and a female in each cage. Breeding cages were made of cheese cloth with bamboo frames for support. These were set upon a kerosene can in which rice plants were transplanted. Access to the insects under observation was through a door on one side of the cage.

Only individuals which emerged from the pupæ in confinement were used in the present investigations. In order to supply material for this purpose, larvæ were brought from the field into the laboratory and there reared under controlled conditions.

Field observations were also made in order to determine the time and place of oviposition under natural conditions, and also the habits of the insect in its various stages. The extent of damage was also studied in the fields both of the College of Agriculture and of private planters in the neighboring districts.

RESULTS

MANNER OF OVIPOSITION

Observations based on five moths seem to indicate that the eggs are laid from one to three days after the emergence of the adults. Oviposition was found to take place in the earlier part of the evening. The female which is about to lay eggs crawls on to the upper surface of the leaf at a distance of about twelve centimeters from the tip. While her head is directed toward the tip she exudes a sticky dark-red fluid from the anus. This process is followed by the eggs which are fastened on the leaf by means of that substance. The eggs are probably held together in a mass by a yellowish fluid, also exuded by the mother between ovipositions. When all the eggs are laid, the mass is covered with hair from the anal tufts of the moth. This is done by dragging the abdominal cauda across

the mass, and with the help of the hind legs the hair tufts are set loose. After oviposition the moth either crawls further forward to the tip or flies to the neighboring plants.

TABLE I.—*Egg masses: Number of eggs in each mass, position, and size.*

Mass number.	Position on leaf.	Distance from tip.	Size of mass.		Number of eggs in mass.
			Length.	Width.	
		cm.	*mm.*	*mm.*	
1	upper	7.8	5.5	3.5	42
2	upper	7.2	5.5	3.5	38
3	upper	9.5	7.0	4.0	54
4	upper	11.6	7.5	4.5	60
5	nether	40.7	8.0	4.0	74
6	upper	5.6	7.0	4.0	58
7	upper	14.3	7.0	3.5	68
8	upper	8.1	8.5	4.5	96
9	upper	12.1	6.0	2.5	48
10	upper	6.2	6.5	4.0	54
11	upper	35.8	7.0	3.0	62
12	upper	7.0	8.0	4.0	72
13	upper	2.5	5.0	3.5	43
14	upper	12.3	7.5	4.0	72
15	upper	7.7	6.0	3.5	68
16	upper	11.6	7.5	3.5	68
17	upper	8.4	8.0	4.5	84
18	upper	7.4	7.5	3.5	68
19	upper	14.7	5.5	3.5	59
Minimum		2.5	5.0	2.5	38
Maximum....		40.7	8.5	4.5	96
Average.....		12.2	6.8	3.7	62.5

With the exception of Egg No. 5, which was laid on the nether surface of the leaf, it will be seen in Table I that the eggs are laid on the upper surface from 25 millimeters to 407 millimeters from the tip, the average being 122 millimeters. The egg masses measure from 5 millimeters to 8.5 millimeters long, the average being 6.8 millimeters, and from 2.5 millimeters to 4.5 millimeters wide, the average being 3.7 millimeters. The number of eggs present in each mass is from 36 to 96, the average being 62.5. As shown in Table II, the length of incubation period ranges from 8 to 9 days.

LARVÆ

Habits.—On hatching, the young larvæ bore holes through the leaf upon which the egg mass is attached. They move on the surface of the leaf at the rate of five to seven centimeters a minute, biting here and there as they proceed until they find a convenient place on which to settle. Sometimes they suspend themselves on a fine silken thread which they spin from their mouths and allow themselves to be carried away by the wind in this position and be landed on another plant. Upon finding a suitable host, the larvæ bore their way through the leaf sheath and finally inside the young stalks. The entrance into the stalk made by the newly hatched larvæ is so small that it is quite inconspicuous. Larvæ which happen to settle on an old, or otherwise hard, stalk usually crawl in between the latter and the leaf sheath and eat off the young lateral shoot, in this manner forming holes large enough for their admittance into the interior. As many as twelve young larvæ may be found feeding within a single stalk, but of the more fully grown individuals there is usually only one present. They are very vora-

cious feeders, soon severing the more distal from the lower portion of the stalk and causing the former to dry up. The insect then migrates into the next lower internode by eating its way through the intervening node. After using up the available food in the original host, the larvæ migrate to another, and the process is continued until pupation. In the present observation, a larva has been seen to use three culms in succession, which in this case happened to belong to three different plants, before reaching the pupal stage.

Description.—The full grown larva usually measures from 20 to 25 millimeters long and from 3 to 3.5 millimeters in diameter. The head and the first segment of the thorax are dark brown, approaching black. The body is creamy white with one light brown dorsomesal and four subregular lateral lines. The body is sparsely covered with moderately long hairs, which grow more thickly at the head and at the abdominal cauda. Moreover, the cephalic and the caudal hairs are longer than those on the rest of the body.

One or two days before molting, the larva ceases feeding. Its color becomes darker and it seldom moves. About twelve hours after molting, feeding is resumed, and the larva eats voraciously during the day as well as during the night. This condition continues until one or two days preceding each subsequent molt when the insect becomes inactive again.

PUPATION

The larva which is about to pupate moves into a lower internode of the rice plant at a distance of from ten to fifteen centimeters, and occasionally thirty centimeters, or higher, above the surface of the ground. A hole is made through the wall on one side of the stalk large enough to allow the adult moth to pass out when it emerges. Silk thread is woven across the hollow of the stalk just above this opening and the latter is then closed with the same material. The larva subsequently moves down to a distance of about two centimeters below the emergence hole, and with the head directed upward it covers itself with a thin cocoon, and the body contracts. A day or two later the larval skin splits dorsomesally from the cephalic region. The young pupa casts off the last larval skin by means of a continuous dorsoventral rocking motion of the body.

The pupa is creamy white at first, but gradually turns brown and then finally red. It usually measures from 9 to 13 millimeters long and from 3 to 4 millimeters in diameter. The head is blunt and the abdomen tapering. During the pupal stage the insect is inactive, moving only when disturbed.

ADULT

The moth emerges from nine to eleven days after pupation. The pupal skin splits along the anterior dorsomedian line and the young moth pushes the old skin back by means of its legs. Then it crawls up and breaks through the silk enclosure across the emergence hole. After the moth escapes it seems to be strong and active, and can run about rapidly on being disturbed. The wings which are folded close to the body expand and dry after a few minutes. About two hours later the wings are ready for flight. If for any reason the wings dry up before they are fully expanded or before the moth has escaped from its imprisoning internode, the insect becomes crippled and remains in this condition for life.

The moth is easily recognized by its yellowish white color and the presence of a black dot at the lower angle of the distal cell of each forewing. The female

usually measures from 9 to 12 millimeters long and the expanse of the wings is from 24 to 28 millimeters; the male is from 8 to 10 millimeters long and the expanse of the wings is from 18 to 23 millimeters. Hampson (13) describes the male as follows:

> Brownish ochreous. Fore wing irrorated with dark scales and the veins slightly streaked with fuscous; a black spot at lower angle of cell; an oblique fuscous line from the apex to vein 2; a marginal series of black specks. Hind wings ochreous white.

Of the female, he writes:

> Head, thorax and abdomen yellowish white. Fore wing suffused with orange-yellow; a black spot at lower angle of cell. Hind wing white, often tinged with yellow towards outer margin.

During the day the moths hide under the thick leaves of the rice plant or among the grass that grows around the field. If they are disturbed they fly about, aimlessly, apparently, before they again seek cover. When disturbed a second-time their flight is faster and usually farther than before, and on lighting they crawl rapidly under the thick, dry leaves so that they are often lost sight of until they fly again. Strong rain or wind does not cause their flight. On the contrary they cling fast to the leaves, or else crawl to the nearest thick growth for shelter. If disturbed at this time they seldom take to their wings.

They begin to become active at sundown, when they are often seen flying out of their hiding places. The direction of their flight is toward the center of the rice field and they alight on the upper surface of the leaf, about midway from the tip. Oviposition mostly takes place during this time.

No close observation was made on the moths during the night, but probably this is the time in which they are most active. While working in the College Library during the nights of the school year 1921-1922, these insects were often seen hovering about the electric lights. Shiraki (1, page 188) on the basis of his observations in Formosa and in Japan, reports that this moth is attracted to light more than other species of night-flying moths.

The activities of the moths begin to lessen at dawn. Their flights at this time are long and are directed toward the dikes or toward the thick grass near the borders of the field. After sunrise the insects are seldom seen on the wing. In fact they appear lethargic, as several specimens showed when these were carried on a leaf in day time from the rice field to the insectary, a distance of about five hundred meters. The insects in this instance did not fly away although the leaves were shaken at times.

LIFE HISTORY

Newly laid eggs were collected from the field, brought into the laboratory and transferred into test tubes, each mass being confined separately and labelled. The mouth of the test tube was plugged with cotton. After four days portions of young stalks of rice were introduced into the test tube to feed such larvæ as might be hatched by that time. The feed was renewed daily thereafter. On hatching, each larva was confined in a separate tube to facilitate making more accurate records. On pupation each pupa was transferred to a separate jelly glass. Adults were kept in confinement in battery jars.

The larva molts seven times, the seventh marking its transition to the pupal stage. As shown in Table II, the duration of the first instar is from 6 days to 9 days, the average being $6\frac{23}{24}$ days; second, from 7 days to 9 days, the average being $8\frac{1}{6}$ days; third, from 7 days to 9 days, the average being $8\frac{1}{24}$ days; fourth, from 8 days to 11 days, the average being $9\frac{7}{24}$ days; fifth, from 8 days to 11 days, the average being $9\frac{5}{24}$ days; sixth, from 10 days to 13 days, the average being $10\frac{7}{8}$ days; and the seventh, from 9 days to 13 days, the average being $10\frac{7}{8}$ days. The pupal stage is from 9 days to 12 days, the average being $10\frac{5}{6}$ days. The moths live from 3 days to 7 days, the average being $4\frac{1}{2}$ days. The total length of the immature life of the insect after laying is from 80 days to 85 days, the average being $82\frac{17}{24}$ days. The insect remains in the larval stage from 60 days to 66 days, the average being $63\frac{5}{12}$ days. (Table II)

SEASONAL OCCURRENCE AND ABUNDANCE

This insect is apparently present in all stages of growth throughout the year, except during the dry months of March, April, May, and the early part of June, when they undergo a period of æstivation as larvæ and pupæ in rice stubble where they are lodged at about the level of the surface of ground. It should be remarked, however, that this observation did not cover irrigated paddies. Occasionally, larvæ in semidormant condition were noted, particularly in deserted *caiñgins*[2] during this period. In July the adults begin to emerge and their sexual activities are evident from the number of egg-masses noticeable in the fields at this time. This condition of affairs continues until February. Egg-masses are found most abundant during September and October, and during January and the earlier part of February. The least number of egg-masses, outside of the period of æstivation mentioned above, is observed during the months of July, August, November, and December.

From the foregoing observation we are led to infer that the period of the insect's greatest activities, when it is capable of doing a large amount of damage is during the months of September and October and during January and the earlier part of February. These months represent the times of the year when the Philippine rice fields are covered with young and tender rice plants, into the stalks of which the *Schœnobius* larvæ can easily gain access.

NATURAL ENEMIES

Enemies of the eggs.—During certain seasons of the year eggs are heavily parasitized by certain hymenopterous parasites which lay their eggs on the egg-mass of the moth. On hatching, the parasite larvæ eat their way into the interior of the host's eggs. The adult parasites are very commonly observed on the rice paddies and are probably the most important natural check of *Schœnobius incertellus*. Shiraki (1, pp. 50-71) reported that the three most important parasites on the eggs in Japan and Formosa are *Trichogramma japonicum* Ashm., *Ceraphron beneficens* Zehnt. and *Tetrastichus* sp.

Enemies of the larvæ.—During migration from one plant to another many of the larvæ perish on the way, either because of their inability to settle in a new host or from the attack of predaceous or parasitic enemies. Three species of

[2] A cleared piece of land on which rice, corn or vegetables are planted in a primitive manner.

parasitic Hymenoptera were reared in the present investigations; these have been sent abroad for identification. Certain species of ants are also important enemies of the pest during this period. Among the other predators observed are the praying mantis, spiders, frogs, centipedes, and birds. The extent of destruction of the larvæ by birds is not great due to the habit of the former of migrating during the evening. Centipedes are perhaps the most efficient predators on the pest at this stage, as they were the insects most commonly found eating the larvæ during the present observations. A smaller species of centipede follows the larvæ through their holes into the hollow of the stalk and attacks them there. A considerable percentage of the larvæ have also been found to die from the attack of a fungus disease.

Enemies of adult.—The habit of the moth of flying at night renders the adult insect quite safe from the attack of birds, dragon flies, and other diurnal predators. Some of the important enemies at this stage which were observed in the present investigations are certain species of spiders which attack them in their hiding places: frogs; *dalag* (*Ophiocephalus striatus* Bloch), which attacks them whenever they rest on a blade of grass near the surface of the water; and mantids.

EFFECT OF INFESTATION ON PRODUCTION

On account of the absence of sufficient reliable data, no definite conclusions have so far been drawn in regard to the extent of damage caused by *Schœnobius incertellus*. With the end in view of contributing information on this important phase of the subject determination of infestation on twelve varieties of rice grown in the different parts of the College Farm during the year 1922 were made. The results are included in Table IV, a summary of which is given in Table III.

TABLE III.—*Extent of infestation on different rice varieties.*

Number.	Name of variety.	Percentage of infestation.
		per cent
1	Makabiag	2.0
2	Daluson	6.9
3	Murmuray	5.6
4	Masinag	0.8
5	Lumbang	8.8
6	Iroy	5.7
7	Pinili	5.2
8	Kinastila	3.2
9	Guininto	32.2
10	Kinagaykay	23.9
11	Kuliit	20.4
12	Inarañgilan	17.3

The first eight varieties were planted to the west of the Administration Building of the College of Agriculture. The surroundings were clean. The last four varieties were planted side by side by two tenants of the College on the Experi-

ment Station grounds. The field was surrounded with tall bushes, talahib (*Saccharum spontaneum* L. subsp. *indicum* Hack.) and other grasses. As shown in Table IV, the damage on these four varieties varied from 17.3 per cent to 32.2 per cent.

Determination was also made on variety Iroy, in December, 1921, and it was found that out of 2621 plants in 7 rows, 744 were damaged, representing a loss of 28.4 per cent.

Supplementary to the foregoing investigations, various *caiñgins* on the slopes of Mount Maquiling were inspected during the months of September and October, 1922, and the damage was found to be not less than 5 per cent on the average. Several visits were also made to different rice fields in the municipalities of Los Baños and Bay, Laguna Province, during the months of January and February, 1923. An approximate estimate of *Schœnobius* damage in these fields would place the figure at between 5 and 10 per cent.

SUSCEPTIBILITY OF DIFFERENT RICE VARIETIES

During the month of June, 1923, eight varieties of rice were planted in the irrigated plots lying side by side behind the Administration Building of the College of Agriculture. The extent of damage on each variety was determined as follows: Three small squares, each measuring one square meter, were marked in each lot; the first square was on that part of the lot where the growth of rice plants was thinnest; the second was on a moderately crowded part of the lot; and the third, where growth was thickest. All the heads inclosed within these respective squares were then counted. The total area of the lot was taken. The product resulting from the total number of heads in the three squares, divided by three and multiplied by the total area of the lot was taken as representing the approximate number of heads in the entire lot.

The total number of heads destroyed in the lot was determined as follows: As soon as signs of attack were observed the white heads were collected, leaving the stalks intact, so that what larvæ they might enclose would be left undisturbed. The white heads collected were then counted. This process was carried out at regular intervals, on Tuesdays, Thursdays, and Saturdays, until the rice was harvested. The numbers of damaged heads collected at different times were added and their sum divided by the total number of heads in the lot, then multiplied by 100. The result is the approximate percentage of heads destroyed in the lot.

The results of the foregoing experiments are given in Table IV.

TABLE IV.—*Relative extent of damage on twelve varieties of rice in the College of Agriculture.*

Variety name.	College number.	Origin of variety.	Place of observation.	Area observed.	Total number of plants in the field.	Total number damaged.	Percentage of damage.
				sq. m.			*per cent*
Makabiag...	17564	Batac, Ilocos Norte...	West of Main Building...	15.6	2325	48	2.0
Daluson.....	17565	Batac, Ilocos Norte...	West of Main Building...	20.0	5000	345	6.9
Murmuray...	17567	Batac, Ilocos Norte...	West of Main Building...	22.0	3850	214	5.6
Kinastila....	17565	Batac, Ilocos Norte...	West of Main Building...	21.5	3843	123	3.2
Masinag.....	7365	Central Luzon Agricultural School.....	West of Main Building...	23.5	2843	22	0.8
Lumbang....	10872	Unknown.....	West of Main Building...	21.0	3675	323	8.8
Iroy.....	5894	Rosales, Pangasinan..	West of Main Building...	25.0	4375	248	5.7
Pinili.....	8196	Morong, Rizal.....	West of Main Building...	21.0	2625	137	5.2
Guininto....	None	Unknown.....	Experiment Station....	4.0	905	291	32.3
Kinagaykay.	None	Unknown.....	Experiment Station....	4.0	821	196	23.9
Kuliit.....	None	Unknown.....	Experiment Station....	4.0	784	160	20.4
Inarañgilan..	None	Unknown.....	Experiment Station....	4.0	400	69	17.3

It will be seen from Table IV that varying degrees of susceptibility are exhibited by different rice varieties. Variety Masinag, with only 0.8 per cent infestation, appeared to be the least susceptible, while Lumbang with 8.8 per cent, represented the greatest amount of damage. Although the former variety shows advantage in that respect, yet it can not be recommended for planting on a large scale, on account of its low stooling quality and the consequent poor yield.

EFFECTS OF SPACING

It was suspected that crowding of the rice plants had something to do with the severity of infestation. Three varieties were planted in the rice field behind the Auditorium of the College of Agriculture in June, 1922. Each variety was planted in five separate lots, lying close to each other. The treatment given to each of the five lots was as follows:

Lot I, distance between plants, 10 cm.
Lot II, distance between plants, 15 cm.
Lot III, distance between plants, 20 cm.
Lot IV, distance between plants, 25 cm.
Lot V, distance between plants, 30 cm.

The percentage of damage in each lot was obtained in the manner described in the preceding discussion. The results are embodied in Table V.

TABLE V.—*Effects of spacing on degree of infestation.*

Variety name.	Plot No.	Area observed.	Distance between hills.	Number of plants per sq. m.	Approximate number of plants in the lot.	Total number of plants damaged.	Percentage of damage.
		sq. m.	*cm.*				*per cent*
Makabiag..	I	17.0	10	154	2618	96	3.7
	II	15.0	15	133	1995	85	4.3
	III	14.5	20	123	1783	82	4.6
	IV	15.0	25	101	1515	24	1.7
	V	18.6	30	125	2325	48	2.1
Kinastila...	I	23.7	10	155	3674	106	2.9
	II	23.2	15	180	4176	148	3.5
	III	21.5	20	175	3763	123	3.3
	IV	23.7	25	145	3437	133	3.9
	V	23.2	30	189	4385	216	4.9
Iroy.....	I	12.2	10	275	3306	168	5.1
	II	12.0	15	224	2688	187	6.9
	III	11.4	20	204	2326	129	5.5
	IV	11.5	25	165	1898	109	5.7
	V	15.6	30	172	2683	138	5.1

An examination of Table V tends to show that distance is not a factor in the degree of infestation by *Schœnobius*. One possible contrary evidence against this conclusion is furnished by variety Makabiag, where among plants set at 101 to a square meter, the extent of damage is only 1.7 per cent, as compared with 4.6 per cent in the more crowded areas.

SUMMARY AND CONCLUSIONS

1. *Schœnobius incertellus* is one of the worst pests of rice in the Philippine Islands. The insect belongs to the family Pyralidæ, order Lepidoptera.

2. The Filipino farmers notice the symptoms of attack but are in general unacquainted with the borer itself.

3. The work of the rice borer is characterized by a total whitening of the entire panicle, including a large part of the contiguous more distal portion of the stalk.

4. Rice borer is reported to be a pest in almost all rice-growing regions in the Orient, notably in Formosa, Japan, India, the Dutch East Indies, French Indo-China, Federated Malay States, and Ceylon.

5. The moth lays its eggs in a mass on the upper surface of the rice leaf, at a distance of about 12 centimeters from the tip.

6. The number of eggs present in each mass varies from 36 to 96.

7. The newly hatched larvæ bore into the stalk and eat up the tender part thus severing the more distal from the lower portion of the plant and inhibiting the formation of grains.

8. As many as 12 young larvæ may be found feeding in one stalk, although there is usually one to each stalk in the case of more fully grown larvæ.

9. The larvæ migrate to another plant after the food in the host is consumed.

10. The larva ceases feeding one or two days before each molt. Feeding is resumed generally 12 hours after the process.

11. Pupation takes place at the lower part of the stalk, at a distance of from ten to fifteen, and occasionally thirty, centimeters, or higher, above the surface of the ground.

12. The moths are active at night, beginning at sundown and ending at sunrise. The adult insects are attracted to light. It is interesting to note that most of the individuals collected by lamplight in the present work were females.

13. During the day the insects hide among the grass or among the thick growth of rice.

14. The life history varies from 84 to 90 days. The period of incubation varies from 8 to 9 days; the larval stage, from 60 to 66 days; the pupal, from 9 to 12 days; and the adult from 3 to 7 days. The total length of the immature stage varies from 80 to 85 days.

15. The insect apparently passes a period of æstivation in rice stubbles in the form of larvæ and pupæ during the months of March, April, May, and the early part of June, and becomes abundant during the months of September and October, January and the earlier part of February.

16. The eggs are parasitized by certain ichneumonid and chalcid parasites which lay their eggs on the egg-mass of the moth.

17. Among the predators of the larvæ are certain species of ants, praying mantis, spiders, frogs, centipedes, and birds. A considerable percentage of the larvæ has been found to die from the attack of a certain fungous disease.

18. The adults are attacked by birds, certain species of spiders, frogs, mantids and *dalag* (*Ophiocephalus striatus* Bloch.)

19. The damage on rice in the College of Agriculture during the year 1922 varied from 0.8 per cent to 32.3 per cent. Different varieties of rice show different degree of susceptibility to the attack of the pest

20. Fields with grassy surroundings and with stubble left after harvest appear to be more susceptible to the heavy attack of *Schœnobius* than the cleaner ones.

21. Spacing has practically no effect on the degree of infestation.

RECOMMENDATIONS

Clean culture of the fields is strongly recommended. Grasses which may serve as alternate host plants and rice stubble wherein the insect may tide over periods between rice plantings should be removed after harvest. Submergence of the stalks in irrigated fields with the idea of killing their inclosed larvæ may also be tried. A more thorough study of their parasitic and predaceous enemies and also of the more important resistant rice varieties will help greatly in the solution of the problem of controlling this pest. Collecting of egg-masses would lessen severity of attack.

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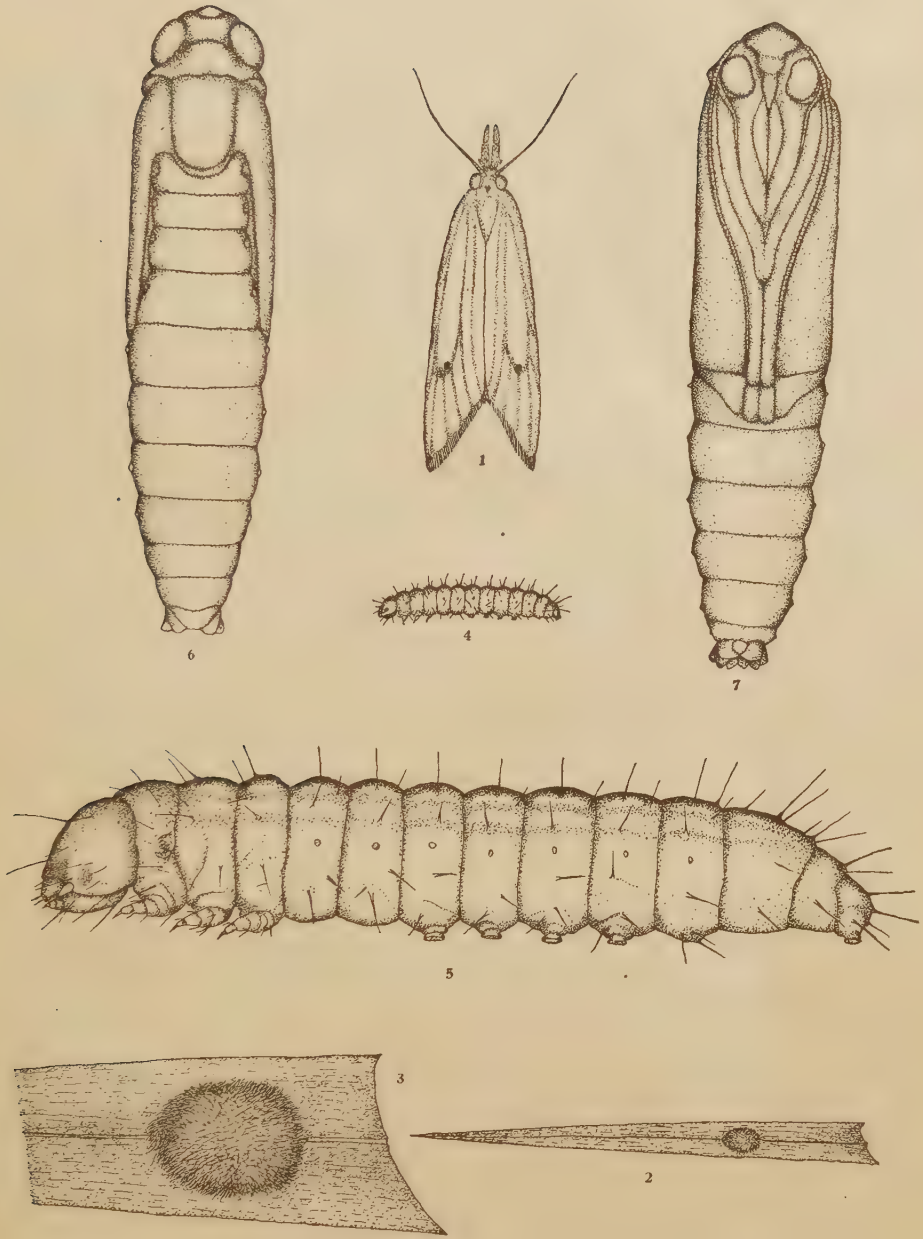

PLATE I

Fig. 1. Adult moth, female, dorsal view. ×2⅔.
2. Egg mass, showing normal position on leaf. ×⅔.
3. Egg mass, enlarged. ×2⅔.
4. Larva, first instar, lateral view. ×6⅔.
5. Larva, full grown. ×6⅔.
6. Pupa, dorsal view. ×6⅔.
7. Pupa, ventral view. ×6⅔.

A STUDY OF THE EFFECTS OF SNAILS AS A SUPPLEMENT TO A RATION FOR LAYING HENS[1]

By Generoso Rulloda Frigillana

INTRODUCTION

Feeding the laying hen properly is one of the most important problems in poultry raising, for feeds and feeding have a direct relation to egg production. According to Philips (1) the hen manufactures eggs from the feed that is given her and the number that she can produce depends a great deal upon the nature of the ration.

There seems to be a difference of opinion among writers on poultry on the question of feeding laying hens. Thompson (2) in his report about the system of feeding from a ten-year egg-laying test which was performed at Hawkesbury Agricultural College and Experiment Farm, Richmond, New South Wales, advocated "full and heavy feeding." He said, however, "Great authorities, among them Lewis Wright, have said 'feed slightly.'" He mentioned further that leading Australian authorities and many foremost American writers have said the same thing. From this it can be seen that the methods advocated are the two extremes, and it is hard for the poultry raiser to choose.

Buss (3) commenting on the subject of feeding laying hens said, "All rations for laying hens should contain a liberal amount of high protein feed secured from an animal rather than from a vegetable source." Philips (4) in results of a four-year experiment showed that the average egg production per hen per year of fowls fed with a ration containing meat feed was 132.8 eggs, while those which did not receive any meat feed averaged only 32.5 eggs. Under Philippine conditions, Fronda (5) of this College reported that egg production from snail-fed hens was higher than that of his copra meal-fed hens. Goseco (6) of the same College also reported that the egg production of his snail-fed ducks was higher than that of his copra meal-fed ducks.

The study here reported is on the effects of ground corn, rice bran, and snails as supplements to a basal ration consisting of palay (unhulled rice) and whole corn for laying hens. The objects were: (1) To find out the effect of snail (crushed and cooked) upon laying hens; (2) to find out which is more efficient and more economical for egg production: a supplement consisting of ground corn, rice bran, and snails or one consisting of ground corn and rice bran.

Snail was used in this study as a part of the supplement for the hens of one lot to further place under trial the results and conclusions deduced by Fronda (5) and Goseco (6).

The study was carried out in the Department of Animal Husbandry, College of Agriculture, Los Baños. It covered a period of seven months from July 6, 1921, to February 6, 1922.

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[1] Thesis presented for graduation from the College of Agriculture No. 161; Experiment Station contribution No. 194. Prepared in the Department of Animal Husbandry under the direction of Mr. M. Mondoñedo.

MATERIALS AND METHODS

MATERIALS USED

Twenty laying Cantonese hens and two Cantonese roosters were used. All these birds were healthy and vigorous. On all the hens, except two, there was a one-year record on egg production.

The ration for each lot was divided into two parts; namely, the basal part and the supplemental part of the ration. The basal portion consisted of shelled corn and unhulled rice and the supplemental portion consisted of ground corn, rice bran, and snail (crushed and cooked). In addition to these feeds, grits, ground charcoal, and fresh water were also supplied.

PLAN OF THE EXPERIMENT

Arrangement of the birds.—The flock was divided into two lots, designated as Lot A and Lot B. Each lot had ten hens and one rooster. In the division of the flock care was taken to secure uniformity in weight, size, and vigor for each lot. Every bird in each lot had a tag number for identification.

Housing and yarding.—One of the poultry houses of the Animal Husbandry Department was used. This house is three and one-half meters wide and seven meters long. It has two compartments, each of which was provided with eight good trap nests, four permanent coops for confining and breaking broody hens, a self-feeder with three compartments, wooden dropping boards one and one-half meters wide and about three and one-half meters long, and three rows of scantlings 45 centimeters apart running lengthwise, for roosts. Adjacent to each compartment was a yard wire fenced, 30 meters by 12 meters, which was divided into two parts so as to allow rotation of pasture. This arrangement of the grass range of each lot gave the birds a chance to have fresh pasture throughout the course of the study. The land in which the poultry house and the grass range are located is well drained and well ventilated.

System of feeding.—Both lots were given a basal ration which consisted of whole corn and unhulled rice in the proportion of one to one by weight. This was supplied to the birds twice a day, at nine o'clock in the morning and at four o'clock in the afternoon.

Feeding was adjusted until an amount which they readily ate was reached. The amount of basal feed given each time after the first week of the experiment was 0.2 kilogram in the morning and 0.3 kilogram in the afternoon for each lot consisting of eleven birds. The object of giving more of the basal feed in the afternoon than in the morning was to have a few grains left on the ground for the birds to pick up early the next morning when they were just off from the roosts.

The supplement for Lot A consisted of ground corn, rice bran, and snail (crushed and cooked); for Lot B it consisted of ground corn and rice bran alone. The ground corn and rice bran were in the dry form and were given separate to the hens by means of self-feeders (one self-feeder for each lot). The snails which were crushed and cooked were given to Lot A in a trough. All of these supplements were placed so as to be accessible to the fowls all the time. This method gave every bird of each lot a chance to eat as it pleased and to balance its own diet. Grits, ground charcoal, and fresh water were accessible to each lot all the time.

EXPERIMENT AND RESULTS

WEIGHT OF HENS

To determine whether the feeds had any effect on the weight of the birds, each bird was weighed at the beginning and at the end of the experiment. Hens of Lot A gained an average of 221 grams in 7 months, while those of Lot B gained 173 grams.

FEEDING

Care was taken in feeding each lot. The self-feeders used were kept always under observation and the supply of supplements ran down continually into the trough. The amount of feed supplied and consumed by each lot was carefully measured and recorded. Table I shows the chemical analyses of the feeds used as analyzed at the College Chemistry Laboratory.

TABLE I.—*Showing the chemical analysis of the feeds.*

Feeds.	Shell.	Meat.	Moisture.	Fat.	Crude protein.	Carbohydrate.	Crude fiber.	Ash.	Undetermined.
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Snail.....	51.56	48.44	78.22	0.75	7.62	7.31		6.06	.04
Corn.....			12.48	4.91	9.37	69.77	1.93	1.54	.00
Palay.....			11.21	8.63	9.50	58.01	5.01	6.88	.76
Rice bran			10.53	15.80	10.98	40.98	9.10	12.61	.00

EGG PRODUCTION

The eggs laid by each hen of each lot were carefully recorded. That egg production by each hen could be determined without difficulty, eight good trap nests were provided for each lot.

The eggs were gathered three times a day, at nine o'clock, at noon, and at five o'clock in the afternoon. Every egg that was laid and collected was numbered with the corresponding number of the hen that laid it and was recorded to her credit.

That comparative data on the weight of the eggs laid could be secured, every egg laid was weighed and recorded. The average weight of 494 eggs laid by Lot A was 41.62 grams., and of 335 eggs laid by Lot B was 39.67.

Calculation was made also on the cost of feed consumed and the value of the eggs produced by the hens of each lot, so as to determine which of the feeds used was the more economical for egg production.

MORTALITY

All the birds of each lot were carefully observed for any disease or other ailment. Any hen that died or showed a decidedly abnormal condition was immediately replaced with a new hen of practically the same age.

One hen died November 18, 1921. Post mortem examination showed that every part of her internal organs was normal. The only trouble found was that an egg ready for expulsion was broken right in the oviduct and this was suspected to be the cause of her death. The egg was probably broken as a result of some accident. Another hen was removed October 7, 1921, because of her extraordinarily fat condition; she had laid no egg since the beginning of the experiment.

These two hens were replaced by two others as soon as they were removed from the lots.

DISCUSSION OF RESULTS

All the birds in both lots, except one in Lot B, gained in weight, but the hens of Lot A gained more in weight than those of Lot B.

TABLE II.—*Showing amount and cost of feed consumed, number and value of eggs produced, and gain over cost of feed.*

Lot.	Grain.	Ground corn.	Rice bran.	Snail.	Total cost.	Total number of eggs.	Value of eggs.	Gain over cost of feed.
	kg.	*kg.*	*kg.*	*kg.*			*pesos*	*pesos*
Lot A. Ground corn, rice bran, and snail-fed.....	107.5	44.5	80.62	86.2		494	34.58	+14.45
Cost.....	₱9.84	₱3.71	₱3.74	₱2.84	₱20.13			
Lot B. Ground corn and rice bran-fed.....	107.5	46.07	120.9			335	23.45	+4.16
Cost.....	₱9.84	₱3.84	₱5.61		₱19.29			

Table II shows the amount of feeds consumed by the birds of each lot during the course of the experiment. From this table it may be seen that the hens of both lots consumed the same amount of basal ration as each lot was given the same amount. Lot A (fed ground corn, rice bran, and snail) consumed a larger amount of supplement than Lot B (fed ground corn and rice bran). Lot B, however, consumed more rice bran and ground corn than Lot A.

In connection with the amount of feed consumed by the birds of each lot it may be mentioned that the computed nutritive ratios were 1:7.1 for Lot A and 1:7.7 for Lot B.[2]

However, it can be seen from the hens of Lot A that one of the evident results of the addition of snail to the supplement was an increased food intake which naturally stimulated fattening and greater egg production.

A sample of snail used was analyzed by the Chemistry Department and was found to consist of 51.56 per cent shell which contains largely calcium, an element essential in the formation of the egg shell, and 48.44 per cent meat. The meat consists of 0.75 per cent fat, 7.31 per cent carbohydrate, and 7.62 per cent crude protein, and 6.06 per cent ash. Here it can be seen that snail contains a good deal of the materials necessary for egg production. The broken shell of the snail also forms a good grit, a thing which is very essential in the process of digestion of the birds.

In all cases, during the seven months of the experiment the hens of Lot A had a higher monthly rate of egg production than the hens in Lot B. Lot A produced 494 eggs in seven months and Lot B produced 335 eggs in the same length of time, giving a difference of 159 eggs in favor of Lot A. The average egg production in Lot A was 49.4 eggs a hen for seven months and 33.5 eggs

[2] The nutritive ratio was computed from the total amount of each part of the basal and supplemental rations consumed by the birds of Lot A and Lot B and from the chemical analyses of the samples of the same feeds. Nutritive ratio = (per cent fat x 2.25) plus per cent carbohydrate divided by per cent crude protein.

a hen for the same length of time for Lot B. This shows that the supplement consisting of ground corn, rice bran, and snail was better for egg production than the supplement consisting of ground corn and rice bran alone.

In Lot A there were five hens that made a slight gain in weight and five other hens of the same lot made marked gains. Those that made slight gains produced 287 eggs in seven months, or an average of 57 eggs a bird while those that made marked gains produced 210 eggs in the same length of time, or an average of 42 eggs a bird. In Lot B, there were three hens that made slight gains in weight, and there were five hens of the same lot that made marked gains. The total number of eggs produced in seven months by the three that made slight gains in weight was 137, or an average of 45.66 eggs a bird, and in the same length of time the five that made marked gains in weight produced 122 eggs, or an average of 24.5 eggs a bird. These figures show that in both lots the hens that made slight gain in weight during the course of the experiment laid more eggs than the hens that made marked gain in weight. The figures also support the common observation that the fat birds after the laying season are usually the idlers. Among individuals that are subjected to about the same treatment there are always some individuals that are better producers than others. Hence, the importance of selecting hens for maximum egg production.

Buenaventura (7) in his experiment, planned to parallel the work here reported, found that the ten hens of his Lot A (fed ground corn, rice bran, and cowpeas) gave a total production of 456 eggs for seven months and the ten hens in his Lot B (fed ground corn, rice bran and copra meal) gave 295 eggs for the same length of time. In Lot A there was an average of 45.6 eggs a hen, and 29.5 eggs in Lot B. The total eggs produced by the ten hens in Lot A (fed ground corn, rice bran, and snail) of the experiment here reported was 494 eggs for seven months or an average of 49.4 eggs a bird. This number of eggs was higher than either that of Lot A or Lot B in Buenaventura's work. This fact tends to show that a ration, the supplement of which contained snail was slightly more efficient for egg production than a ration the supplement of which contained cowpeas, and vastly more efficient than one containing copra meal.

The total weight of the 494 eggs in Lot A was 20,558.7 grams, or an average of 41.62 grams per egg, while that of the 335 eggs in Lot B was 13,289 grams, or an average of 39.67 grams per egg. This shows that the eggs produced by the birds with ground corn, rice bran, and snail for their supplement were slightly heavier than those produced by the birds which were given only ground corn and rice bran. The difference was probably due to the greater amount of available protein and mineral matter in the feed of the former than in that of the latter.

The average number of eggs a bird in Lot A was practically the same as that in Lot B before the study began. During the experimental period, hens of Lot A improved very much over their previous egg production while those of Lot B made practically no improvement at all. This is shown by the fact that the previous average of egg production a bird for seven months was 32.87 eggs for Lot A and 33 eggs for Lot B, while the average production of eggs a bird for the same length of time during the experimental period was 49.4 eggs for the former and 33.5 eggs for the latter. This fact also seems to show plainly that the supplement consisting of ground corn, rice bran, and snail was more efficient for egg production than the supplement consisting of ground corn and rice bran alone.

Table II shows the relative cost of egg production from each lot. In the computation of the cost of feed consumed, only the basal and the supplemental feeds were considered. The computation was based on actual prices of feeds in this locality. They were as follows: Corn and ground corn at ₱1.00 per 100 ears shelling on an average 12 kilograms or 8.33 centavos a kilogram; rice, palay at ₱4.30 a cavan, or 10 centavos a kilogram; rice bran at ₱1.30 a cavan of 28 kilograms or 4.64 centavos per kilogram; twelve liters of snail for 40 centavos, or 3.3 centavos per liter which is approximately 1 kilogram.

Eggs sold at 7 centavos each.

By reference to Table II it may be seen that at the prices quoted the total expenses for the feed consumed in Lot A was ₱20.13 and the total value of the eggs was ₱34.58 making a net gain of ₱14.45 over the cost of feeds. The cost of the feeds consumed by hens in Lot B was ₱19.29, and the total value of the eggs was ₱23.45, a net gain of ₱4.16 over the cost of feeds. Comparing the gain from the lots, it is seen that Lot A was $10.29 greater than Lot B. This shows that it was more economical to use ground corn, rice bran, and snail for supplement than to use ground corn and rice bran alone.

SUMMARY AND CONCLUSIONS

1. All the birds in both lots, except one in Lot B, gained in weight. The average gain a bird was more marked in Lot A (fed ground corn, rice bran, and snail) than the average gain in Lot B (fed ground corn and rice bran).

2. Lot A consumed a greater amount of feed than Lot B. Both lots consumed the same amount of basal feed, but Lot B consumed a greater amount of corn meal and rice bran than Lot A. The greater consumption by Lot B was especially marked in the rice bran. The computed nutritive ratio was 1:7.1 for Lot A and 1:7.7 for Lot B.

3. Lot A produced 494 eggs in seven months, while Lot B produced 335 eggs in the same length of time. This shows that the birds fed with a supplement consisting of corn meal, rice bran, and snail, were better egg producers than those which were fed with supplement consisting of corn meal and rice bran alone. The hens in each lot which were heavy layers made but slight increase in their weight while those that were poor layers made marked gains. The comparison in egg production for the same length of time, between Lot A (snail-fed) of this experiment and that of either Lot A (cowpea-fed) or Lot B (copra meal-fed) of Buenaventura, shows that the former gave 494 eggs and the latter two gave 451 eggs and 294 eggs respectively. This seems to indicate that snail is a better supplement for egg production than either cowpea or copra meal.

4. The eggs laid by the birds fed with ground corn, rice bran, and snail were heavier than those laid by the birds fed only with ground corn and rice bran alone.

5. All the hens in Lot A made marked improvement in egg production during the experimental period compared with that of their previous record, while Lot B practically did not improve at all. This shows that supplement consisting of ground corn, rice bran, and snail, was much better for egg production than that which consisted of ground corn and rice bran alone.

6. The hens of Lot A made a net gain of ₱14.45 and those of Lot B ₱4.16. The cost of feed consumed by each lot was almost the same. This shows that

it was more econominal to produce eggs with the addition of snail to rice bran and ground corn than without it. (Table II.)

RECOMMENDATIONS

1. Snail (crushed and cooked), whenever available and not expensive, is a very good supplement to the ration of laying hens.

2. Once good egg layers are selected, hopper feeding of dry mash as a supplement to a scratch ration of whole grains, is recommended. This method allows the hens to balance their own diet, thus saving labor and attention, besides promoting cleanliness in feeding.

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STUMBLING IN HORSES[1]

By Louis P. Koster
Of the College of Veterinary Science

Faulty action in horses is always annoying and no defect is more troublesome than that of stumbling. Not only may the animal inflict serious injury upon itself but the safety of the occupants of a vehicle may be endangered by its occurrence. When the horse is under saddle stumbling is a constant menace to the rider and may be followed by the most direful consequences. Efforts at correction are usually without avail and the time-worn adage "once a stumbler, always a stumbler," bears eloquent testimony to this fact. The purpose of the present article is to correct certain misconceptions in regard to stumbling and to direct attention to, and to emphasize the importance of, certain mechanical features which are not generally recognized as being associated with the act.

Stumbling may be defined as that defect in gait in which the foot of a swinging foreleg comes in premature contact with the ground while that member is still more or less flexed. While this definition is substantially correct, it is misleading to the extent that by inference it designates the swinging leg as the one at fault, whereas just the opposite is the case, as the fault exists in the supporting leg, as will be shown later. Fatigue, overlong toes, and natural awkwardness are frequently given as causes of stumbling by interfering with or delaying the "breaking over" process at the toe, thereby preventing sufficient elevation of the foot during the stride to clear all ordinary obstacles. Such an assumption definitely accuses the swinging leg as the offending member and creates a distinctly erroneous impression. The small measure of success that attends efforts aimed at increasing the height of the stride and facilitating the "breaking over" process of the foot is significantly indicative of the fallacy of the theory. The problem is to be viewed primarily from the standpoint of the supporting leg.

Close observation of an inveterate stumbler in motion will disclose, that just before, but almost coincident with stumbling, there occurs a slight bending of the knee of the leg bearing the body weight. The yielding of the supporting column permits the body to drop to the extent of allowing the toe of the foot of the swinging leg to strike the ground while being carried forward and there follows a temporary and whole or partial loss of body equilibrium.

DEGREES OF STUMBLING

The extent to which the animal retains or loses control of its balance will depend upon the position of the free limb at the time the supporting leg gives way. Thus, different degrees of stumbling are to be recognized.

Should the swinging leg occupy a position just anterior to the supporting leg when the latter yields, the animal will, by a quick movement and by throwing up the head, generally be successful in advancing the swinging leg in time to catch and support the weight of the body. When a horse recovers himself in this manner without falling he is said to have made a "misstep" or to have merely

[1]Experiment Station contribution No. 195.

"stubbed his toe". In such case the toe comes in contact with the ground while it is being extended and brought forward and a little earth or scratched surface may be found on the toe of the shoe or lower part of the wall at the toe.

Should the supporting leg yield at that stage in the phase of flight when the knee of the swinging leg is only slightly in advance of it and when extension of the swinging leg from the fetlock down has not yet commenced, that part of the swinging leg from the fetlock down will be forced against the ground. The animal while falling may be seen to make one or more desperate efforts to regain its feet, but the swinging leg is fast against the ground and cannot possibly be released and extended. This condition could only result from the animal's weight having been thrown upon the leg before that member was in a position to receive and support it. An inspection of the limb after the accident will reveal a mark along the entire front of the foot and an injury extending along the front of the coronary border, the pastern, and the fetlock joint. The nature of the injuries, particularly the upward thrusting of the hair, clearly indicates that they have been caused by the part having been forced backward against the ground. The horse goes down by plunging forward and, if the driver pulls hard on the reins, the animal may be prevented from extending its head and neck, thus making the collapse so complete that the inside of the lips may be cut with the incisor teeth through the chin coming in contact with the ground. This explanation also serves to show the absurdity of the statement commonly made by riders and drivers that they have "held up" a horse while stumbling.

Should the foot of the swinging leg occupy a position in line with or slightly behind the supporting leg at the time of stumbling a portion of the front part of the foot will be forced against the ground and the animal's efforts to regain its feet will be unsuccessful to the extent of causing both knees to be injured. These differences in stumbling are of degree only and are dependent upon the position the swinging leg occupies at the time the supporting leg yields.

THE CAUSES OF STUMBLING

The great majority of cases of stumbling, possibly as much as 90 per cent, are the result of the supportive structures of the limb carrying the body weight being out of proper alignment and relation with each other. This condition is due to faulty conformation or more often to a so called unbalanced foot, that is, one the supporting surface of which has been left uneven and not level by injudicious trimming of the hoof or faulty fitting of the shoe.

When in motion the free limb makes contact with the ground and the body weight is shifted upon it, its direction at first is oblique from above to below and from behind to before. During the phase of flight of the opposite limb the body gradually moves forward upon the supporting limb, the foot of which serves as the pivotal point. As a consequence, during progression the direction assumed by the supporting leg gradually changes until it becomes by degrees first vertical and then oblique from before to behind. It follows, therefore, that the burden of supporting the body weight is transferred successively from one part of the fixed leg to another while these changes in its direction are taking place and we may infer that the part of the supporting leg undergoing the greatest amount of strain, or subjected to the greatest change, will be indicated by the position of the swinging limb at the time stumbling occurs. Since the position occupied by the free

limb can be determined by the degree of stumbling we may consistently conclude that in all cases of stumbling where the animal does not fall, the position of the supporting limb is vertical.

The center of gravity of the body is displaced at every step and the weight is constantly being transferred from one limb to another when locomotion is in progress. The body is falling and nothing but the timely arrival of the opposite limb to a position where it can catch and support it will prevent its falling to the ground. The limb was intended to perform this function and is normally provided with the necessary strength, not only when in a vertical position, but its many parts are so arranged and adjusted as to permit of a change in its position without detracting from its strength and comfort.

When the body weight is first received upon the extended limb the incidence is from above and in a downward and backward direction and strain falls largely upon the strong and more or less elastic structures located in the posterior part of the leg. The foot being fixed upon the ground as the body moves forward the position of the limb approaches the vertical and the weight passes through its center and through that part of the foot known as the quarters. This is the crucial stage and the quarters must now be depended upon. If for any reason, insufficient support is given to one side, the limb will suddenly be displaced in that direction and injury to the lateral ligaments will often compel the animal to yield to the increased strain. The cause of insufficient support being given to one side of the limb is due to some condition, either pathological or mechanical, which renders the limb unable to bear pressure on that side with comfort and as a result it yields and permits the body to drop. The tendons have full control over extension and flexion and, though not possessing much elasticity in themselves, they are still capable through the muscles above, of which they are in reality continuations, of adjusting their length to the extent of escaping injury. The ligaments, on the other hand, while playing a very important part in preventing or at least limiting, movement of the joints to either side, are non-elastic, or only very slightly so, and are unable to adjust themselves to an abnormal position.

While any condition which prevents a limb from performing its function with ease and comfort may be a cause of stumbling, diseased and pathological alterations, particularly those giving rise to lameness, are not apt to do so, for the reason that lame horses in traveling prevent to some extent the weight of the body falling upon the affected member. "Breaking over," which is essentially stumbling behind, can, however, often be accepted as a symptom of incipient spavin.

METHODS OF CORRECTION

Bearing the foregoing considerations in mind, it seems reasonable to assume that any collapse, whole or partial, in the supporting leg must of necesity be due to a lateral displacement of the weight borne by the limb since the structures of the front and rear of that member adjust themselves to unusual conditions with great facility. Furthermore, whether stumbling is caused mechanically, or is due to the presence of an abnormal or pathological condition in the limb, the result is due to weight being imposed upon some part not capable of sustaining it. Our object therefore must be to change the incidence of the weight to some other and stronger part. If the fetlock joint is inclined to the inside of an imaginary

line dividing the limb into lateral halves, the support of the limb in that direction must be increased. This may be accomplished by fitting the shoe full or flush on the inside of the foot and close or base narrow on the outside. If the opposite is the case the conditions and the remedy will be reversed. All deviations in a lateral direction from the normal alignment of the bones of the limbs are due either to faulty conformation or to a faulty base of support and the latter is chiefly attributable to the foot not being level. When these two factors co-exist, as not infrequently happens, the effect on the inclination of the limb is, of course, exaggerated. An even tread of the foot and uniform wear of the shoe must be obtained. To do this, when trimming the hoof, the bearing surface must be made as nearly level as possible. Unfortunately there is no reliable guide for the shoer to follow in this operation, entire dependence must be placed upon his intuitive faculty or mechanical "eye."

As regards the fitting of the shoe, every part of the coronary region in the posterior part of the foot must receive support from the shoe below. If, for example, the outer quarter at the coronet projects beyond its plantar border the outer branch of the shoe from the last nail hole back must be fitted so full that an imaginary line dropped from the coronary band will fall just in line with the outer border of the shoe. Upon examining a foot from the rear the distance from the center of the frog to the two heels should be equal. A simple but quite useful method of determining whether or not the work of the foot and limb is properly distributed is to raise the opposite foot, thereby throwing all the weight upon the limb being examined. If the horny structure growing from the back of the fetlock joint and known as the "ergot" is found to occupy a position directly over the depression between the bulbs of the heels the weight on the limb may be considered as being equitably distributed. If shoeing is performed in accordance with the foregoing principles great improvement in the gait of many horses will be effected even though manifest unsoundness exists in the limbs. Occasional stumbling will, of course, occur in any animal whether sound or unsound, and well shod or otherwise. Such cases are referable to the animal stepping upon a loose stone or into a depression of the road; conditions which obviously cannot well be avoided.

IMPROVING PHILIPPINE SWINE: I[1]

By B. M. Gonzalez and F. P. Lago

Of the Department of Animal Husbandry

In 1916 when the senior author took charge of the animal husbandry work in this College there were in the department a number of individuals of two improved breeds of swine, the Berkshire and the Duroc Jersey. These hogs were from the Bureau of Agriculture. Some of them were animals imported direct from the United States, but the majority were born at the Alabang Stock Farm, the offspring of imported animals.

These pure bred hogs formed a nucleus for a herd of Berkshire and Duroc Jersey breeds in the College. We desire to give here for the information and guidance of raisers of improved swine the record of these animals, and the results of later efforts. Records such as these are rarely found in print, for people rather talk of their successes than of their failures. As to whether these records show our failures or that of the animals, we leave to the reader to decide. We do not know of any improved breed of swine that is fully established in the Islands, or, to be more specific, one in its fifth generation or beyond. Many hog men have tried raising the improved breeds but with experiences similar to what we give in this paper.

THE DUROC JERSEY AND ITS GRADES

PURE DUROC JERSEYS

There were one boar and six sows in the original herd. Three out of the six sows produced litters averaging six pigs each. One of them farrowed twice. The boar and five of the sows died of kidney worms some time between the age of one year and one and a half years. The other sow was in good condition but would not breed. She was butchered and was found to be heavily infested with kidney worms. From our experience with this disease we feel pretty certain that this animal would have died from it in time.

We raised a second generation of pure breeds from this stock, consisting of four males and two females. The average length of life of these six animals was 185 days, varying from 62 to 232 days. Post mortem findings indicated that they all died of kidney worms, in some cases associated with lung worms. None of the females farrowed. This was the last of the pure herd.

BERKSHIRE X DUROC JERSEY

After the Duroc Jersey boar died, there was left one of the original Duroc Jersey sows, which remained in good condition. This was bred to a Berkshire boar. From this was raised a litter of six pigs, the average length of life of which was 211 days, ranging from 99 to 316 days. Our records show that these animals all died of kidney and lung worms. As none of them bred, this cross ended with these individuals.

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[1]Experiment Station contribution No. 196.

DUROC JERSEY X NATIVE

Two native sows were bred to a Duroc boar, one of them producing three litters, and the other, one, with a total of 24 pigs or 6 pigs to a litter. Six of these pigs died rather young. Of those that remained, 6 out of 18, or 33 per cent, were females, of which only one farrowed, a litter of three pigs which she was not able to raise. All these sows died of kidney worms at an average age of 382 days. The remaining 12 of the 18 pigs, 4 males and 8 females, were finally butchered or sold. The boar pigs showed no promise of turning into good individuals and were castrated. Four females were bred to the Berkshire boar and farrowed once each and raised 5 out of a total of 14 pigs born, or an average of three and one-half pigs to each litter and one and one-fourth pigs raised to each sow and litter. The more promising of the sows were kept for over two years, but never farrowed again.

DUROC JERSEY-NATIVE X BERKSHIRE

The progeny of these grade sows out of a Berkshire boar, which were 50 per cent Berkshire, 25 per cent Duroc Jersey, and 25 per cent Native, were four males and one female.

Their length of life averaged 249 days; they died of either kidney worms or hog cholera, without leaving any progeny. This was the end of the Duroc-Native cross, as well as of any Duroc blood in our herd from this introduction.

THE BERKSHIRE AND ITS GRADES

PURE BERKSHIRES

During the last seven years we have introduced into the College 18 Berkshire pigs, 5 boars and 13 sows. These have been introduced at various times.

With the exception of one which was unable to impregnate at times sows known to be fertile, all the boars were fully fertile. Three boars died having lived on an average about two and a half years; the shortest life being two years. All these animals died of kidney worms. Two boars are still living and are apparently in perfect health; they are now about two years old.

Of the 13 sows, 7 have proven absolutely sterile. Of the remaining six, one farrowed dead pigs, five farrowed an average of 5.8 pigs each; three of these raised two pigs a piece. Those that are dead had an average length of life of 783 days. Some of these sows never came in heat, but the majority took the boar but never farrowed. Two of these sterile sows are still living. They are approximately two years old, have been bred repeatedly but never farrowed.

Six sow pigs from three mothers were raised from the introduced stock. Three died of kidney worms leaving no progeny; two when about six months old, and the other when a year and a half of age. Three are still living. They are approximately two and a half years old now, have bred but not farrowed.

From the facts given above, one can see that the outlook for continuing the production of pure bred Berkshires is not at all promising.

BERKSHIRE X NATIVE

Observations and experience both in the College and elsewhere had led the senior author to have grave doubts of success with the pure breeds. Accordingly a program of grading up native swine was begun as soon as possible. The success of our efforts with the use of the Duroc Jersey breed has been described above.

Among Native pigs in these Islands, those coming from Jala-Jala, a town in Rizal Province, have long held a reputation for relatively good size and conformation, early maturity, and especially for the quality of quick and economical fattening. They have these characteristics in addition to the more general characteristics of Native pigs of high fertility and of being good mothers. For these reasons, this strain was selected on which to build up our grading work.

Three sow pigs were purchased in 1915 by Mr. José Cui, a former student of the College. When these pigs matured they were bred to pure breed boars and they gave us in all 90 pigs in 14 litters, an average of almost 5 litters to each sow and six and a half pigs to a litter. They lived approximately four years and finally succumbed to kidney worms, all dying within one month.

We wish to emphasize the following facts in this connection; these three sows were housed, cared for, and fed exactly the same rations as all the other pigs in our care. They reproduced regularly under these conditions. It seems to be a fair assumption, therefore, that there is nothing radically wrong with our conditions. The behavior of these sows may be looked upon as a standard with which the crosses may be compared.

Our pigs in this project have been numbered consecutively since the beginning of this work and in this discussion only the solid block of numbers representing the pigs already dead, from disease, or slaughtered, and those sold, are included. A limit had to be selected, as our remaining pigs are of different ages and nothing can be foretold of their future behavior. This number includes practically all pigs born before August 5, 1920.

Fifty-eight pigs are recorded as being 50-50 Berkshire-Native grades. Twenty-four of these were either sold or butchered and 34 died at an average age of 343 days. Eight of the latter, or 23 per cent, died of kidney worms at an average age of 500 days. Other causes of death were hog cholera, intestinal parasites, emaciation due to obscure causes, etc. Of 14 sows that lived at least a year and a half, or 548 days, only 4, or 29 per cent, proved fertile. The rest were slaughtered at an average age of 630 days. The 4 fertile sows gave us 45 pigs in six litters or an average of seven and a half pigs to a litter. One of them, No. 97, is credited with 22 pigs and three litters. There were other sows which farrowed but died before they were one and a half years old.

There were 30 pigs out of first grade Berkshires by a Berkshire boar (75-25). Using the common breeder's term we shall designate them as three-fourths Berkshires. Nineteen of these were either sold or butchered. Eleven died at an average age of 363 days, two of kidney worms, and the rest of hog cholera. Of four sows that lived over a year and half, or 547 days, two were fertile, Nos. 114 and 135. No. 114 gave us two litters with a total of 16 pigs before she died. Sow 135 is still living. She is the last pig in the series included in this study; she was included because all her litter-mates are and she has already proven her ability as a breeder. She is now three years old and has already given us three litters. She traces back to the prolific sow No. 97 mentioned in a previous paragraph. We have followed and are following up the progeny of these two sows. We have pigs now two generations removed from these animals. They are the concrete result of seven years efforts in the improvement of native swine. These animals have gone through the most rigid test of natural and artificial selection. They have been exposed continuously to kidney worm infestation and have de-

veloped a high degree of resistance to it. They have also gone through a severe epizootic of hog cholera, in which we lost 64 per cent of our herd.[2] Their vitality and fertility have been the object of very close selection. The result of our further efforts in the improvement of Philippine swine using these two sows as a basis will be the subject of another paper.

KIDNEY WORMS

As may be noted in the foregoing discussion, kidney worm infestation was the most active agent in causing the mortality of the pigs. A summary table is here presented.

TABLE I.—*Pigs dying a natural death.*

BREED	Total number.	Average age.	Died of kidney worms.	Average age.	Per cent.
		days		*days*	
Duroc Jersey (introduced)	7	450	6	470	85
Duroc Jersey (locally raised)	6	185	6	185	100
Berkshire x Duroc Jersey	6	211	6	211	100
Duroc Jersey x Native	6	382	6	382	100
Duroc Jersey-Native x Berkshire	4	249	2	220	50
Berkshire (introduced)	10	769	7	841	70
Berkshire (locally raised)	3	310	3	310	100
Natives (introduced)	4	1137	2	1270	50
Berkshire x Native (50-50)	34	343	8	500	23
Berkshire x Native (75-25)	11	363	2	407	18

The percentage of mortality from kidney worms of improved breeds is noticeably high, especially when it is considered that most of them died young. Comparing the pure breeds raised in the Animal Husbandry Department with those brought in, there was a higher mortality among those locally raised. This may be due to the lowering of the resistance of the animals through long residence under adverse conditions.

The high percentage of mortality among the native sows is more apparent than real. These animals lived about their span of life. They had to die of some cause through weakened resistance due to old age, and so fell victim to kidney worms. The two other native sows died of hog cholera, at a comparatively young age. The improved resistance of Berkshire-Native crosses is very evident.

Observation throughout the Islands has shown that kidney worm is the most serious disease of improved breeds. This condition is aggravated by the fact that the disease is present in Native pigs and so is very widespread. Native pigs, however, are very resistant to it, few if any young Native pigs die from it, but they are a continuous source of infection to foreign pigs.

The kidney worm (*Stephanurus dentatus*) is a worm cylindrical in shape, rounded at the extremities, and about an inch to two inches long. Its color is

[2] GONZALEZ, B. M. Hog cholera at the College of Agriculture. **Philippine Agriculturist, 10:** 347-348. 1922.

irregular, because the contents of the alimentary canal show through its transparent skin thus making it gray or dark in patches. It attacks the liver principally, also the fat around the kidneys, the kidneys themselves, and the spleen to some extent. It may lodge itself in the ureters, thus blocking urinary passage and causing uremic poisoning. The symptoms are most variable. The animal apparently may be in good health, yet drop dead suddenly without much of a warning or a preliminary period of illness, but usually the affected animals are greatly emaciated and weaken gradually until death. In some cases there is diarrhœa; while in others, constipation. The urine is highly colored and voided with some difficulty. Upon examination of the dead animal the organs affected are revealed to be putrid, discolored, and filled with the debris of the worm. The worm itself is found. There is no treatment known, but chances of infection from native pigs may be minimized by keeping pure breeds apart from them, and by exercising the utmost cleanliness in the pens and paddocks.

FERTILITY

Another evident failing of pure breeds under our conditions is the poor fertility of the sows. The accompanying table illustrates this point concisely. While comparatively newly imported sows are fairly fertile, they apparently degenerate steadily with each succeeding generation. It seems as though their vitality (if non-fertility may be taken as a sign of weakened vitality) holds on for some time but finally gives way due to the unsuitableness of the environment. None of our pure breed sow pigs locally raised showed signs of fertility. All the pure breed males that we have had were fertile. The grade sows, as may be expected, were better. Infertility among native swine while comparatively low is not as rare as one might suppose from casual observation.

TABLE II.—*Fertility of sows.*

	No. of sow pigs raised.	Sows attaining 1 yr. age or over.	No. Fertile.	Fertile.
				per cent
Duroc Jersey (introduced)	6	6	3	50
Duroc Jersey (locally raised)	2	0	0	0
Berkshire x Duroc Jersey	1	0	0	0
Duroc Jersey x Native	13	10	5	50
Duroc Jersey-Native x Berkshire	1	0	0	0
Berkshire (introduced)	13	12	6	50
Berkshire (locally raised)	6	4	0	0
Native (introduced)	10	10	8	80
Bershire x Native (50-50)	32	24	8	33
Berkshire x Native (75-25)	16	7	2	17

SUMMARY

In this first report of our efforts to improve Philippine swine, a detailed review of the results of introducing pure breeds of swine, that is, Duroc Jersey and Berk-

shire are presented. At least, under our conditions, the perpetuation of pure breeds has proven impossible because of kidney worms. Our efforts to grade up Native swine with Duroc Jerseys have also failed. Grading up with Berkshires, while accompanied with great difficulties, because of deaths caused by kidney worms especially, and poor vitality and low fertility, have left enough individuals that have stood all the tests of the environment. These animals are now being utilized to form the foundation of an improved breed better adapted to Philippine conditions.

COLLEGE AND ALUMNI NOTES

Dr. Robert L. Pendleton, formerly Director of Agriculture, Gwalior State, India, has been appointed Professor of Soil Technology and is in charge of the work in soils in the Department of Agronomy. He graduated from the University of California with the degree of Ph. D. in 1917, and from 1918 to the date of his appointment here worked in India directing experimental and demonstration work in agronomy, animal husbandry, and veterinary science. His division will be housed in the new building which is being erected by the bridge.

The Los Baños Intramural Track and Field Meet will be held in November. Teams will, as usual, be divided by classes and the winners will constitute the nucleus of the Unit IV (Colleges of Agriculture, Veterinary Science and Forest School) inter-collegiate team.

With the forfeiting by the College of Engineering of their basket ball game with Unit IV on October 28, Unit IV retains its sixth successive championship in basket ball. With the return of Rabaya to the Forest School Unit IV has material for three basket ball teams any one of which is thoroughly competent to hold the University Championship.

The College of Agriculture through the work of Calvo, Oliveros, Batao, and Villa was first University Champion in boxing. The College received the first award of the Captain Davis Cup which is to be awarded annually for this sport.

The Unit IV baseball team representing the Colleges of Agriculture, Veterinary Science and Forest School team won two games from the Tayabas Provincial High School at Lucena on October 27 and 28. The team was accompanied by Professor Hester, Doctors Montemayor and San Agustin. Inasmuch as Unit IV has held the University Championship for several years past the team represents the entire University and plays under the colors of the institution. The fact that the athletes were entertained at *thé dansant* at the Provincial Dormitory for Girls on the afternoon of the first game is expected to bring out many more candidates for the squad.

Dr. G. O. Ocfemia returned to the Islands in September after three years study at the University of Wisconsin. He majored in plant pathology under Professor L. R. Jones, and took botany and agricultural bacteriology as his minor subjects. His research problems were in connection with the Helminthosporium disease of rice occurring in the Southern United States and in the Philippines. Doctor Ocfemia has resumed his former position as instructor in plant pathology.

Loyalty Day, October 10, was fittingly observed in the College of Agriculture, the only College of the University of the Philippines in which it is an official holiday. The day's program consisted of a military parade of the local regiment of the U. P. Corps of Cadets and a literary program in the morning, and a military competition which occupied the entire afternoon.

Felix B. Sarao, '17, was recently appointed instructor in Animal Husbandry in this College. Mr. Sarao was employed in the Department of Mindanao and Sulu from 1917 to 1920, and in 1920-1921, he was with Doctor Copeland in Chico, California. He attended the University of Wisconsin in 1921-1922, from which he was graduated with the degree of Master of Science in June 1922, majoring in dairy husbandry. Before returning to the Islands Mr. Sarao worked for a time as a farm help on a dairy farm in West Allis, Wisconsin.

Among the delegates to the annual convention of the Philippine Sugar Association who visited the College on October 7, 1923, were the following alumni of the College of Agriculture: Tranquilino D. Ventura '19 of the Pampanga Sugar Development Company; Jose C. Miraflores, '15 of Manapla, Occidental Negros; Andres P. Goseco, '20, of Guagua, Pampanga; Silvestre Asuncion, '12, who is in charge of sugar cane investigation work of the Bureau of Agriculture, and Jose Q. Dacanay, also from the Bureau of Agriculture.

Doctor Uichanco of the Department of Entomology, and Doctor Mendiola of the Department of Agronomy visited Paete, Laguna, during the latter part of the month of September to investigate the abaca heart-rot situation in that locality. Abaca heart-rot is a serious menace to the hemp industry in the Islands.

Perpetuo Gavarra, '23, is back in the College taking some post-graduate courses in agronomy. Mr. Gavarra was one of the active officers of the Second Regiment of the U. P. Corps of Cadets during his last year in the College.

Doctor Fronda of the Animal Husbandry staff, accompanied by his class in advanced poultry husbandry, visited the Alabang Stock Farm on October 6. Mr. Alcasid, '19, the superintendent of the farm, showed the party around the plant.

Ambrosio Abesamis, '21, is now in charge of the cattle breeding station of the Bureau of Agriculture at Bayombong, Nueva Vizcaya. Mr. Abesamis was formerly stationed at the stock farm of the Bureau in Alabang, Rizal.

Felix Telado, '22, is a travelling agricultural assistant in British North Borneo. He arrived there May 6, 1923. His present post office address is Sandakan, British North Borneo.

Simeon Panganiban, '20, is in charge of the Lanao Cattle Ranch located at Malabang, Lanao. He writes that there are thousands and thousands of hectares of public land around Malabang, Lanao, available for interested alumni. The principal crops around that region are coconut, sugar cane, rice, and corn.

Guillermo Tabios, a former student of this College, writes that he is now running his own stock farm which is located just opposite the place of Mr. Florentino Cruz, '16. Mr. Tabios' stock consists of 50 head of excellent native cattle and Indian bulls. In 1921 Mr. Tabios was in charge of the government ranch in Bukidnon for some time.

The Rizal Center Fraternity at Los Baños has recently inaugurated monthly literary meetings. At the first meeting, in September, papers were read by Dr. R. B. Espino, the Supreme Noble of the Fraternity and Mr. Pedro Rodrigo, Noble Secretary. At the October meeting Mr. Zósimo Montemayor read a very interesting article on capital and interest; Mr. Antonio Luzuriaga held his audience with Warden's well-known chapter on Friendship; and while Mr. Fausto Natalio read Milton's Purity of Life.

This table was inadvertently omitted in printing Vol. XI

TABLE II.—*Life hi*

Egg No.	Date laid.	Date hatched.	Incubation period.	First molt.	First instar.	Second molt.	Second instar.	Third molt.	Third instar.	F
			days		*days*		*days*		*days*	
	11–XI–22	19–XI–22	8	26–XI–22	7	3–XII–22	7	12–XII–22	9	2
	11–XI–22	19–XI–22	8	28–XI–22	9	7–XII–22	9	15–XII–22	8	2
I	11–XI–22	19–XI–22	8	26–XI–22	7	4–XII–22	8	12–XII–22	8	2
	11–XI–22	19–XI–22	8	26–XI–22	7	4–XII–22	8	11–XII–22	7	1
	13–XI–22	22–XI–22	9	28–XI–22	6	6–XII–22	8	13–XII–22	7	2
	13–XI–22	22–XI–22	9	29–XI–22	7	7–XII–22	8	14–XII–22	7	2
II	13–XI–22	22–XI–22	9	28–XI–22	6	7–XII–22	9	15–XII–22	8	2
	13–XI–22	22–XI–22	9	28–XI–22	6	5–XII–22	7	13–XII–22	8	2
	21–XI–22	30–XI–22	9	7–XII–22	7	15–XII–22	8	23–XII–22	8	
III	21–XI–22	30–XI–22	9	8–XII–22	8	16–XII–22	8	24–XII–22	8	
	21–XI–22	30–XI–22	9	7–XII–22	7	15–XII–22	8	23–XII–22	8	
	23–XI–22	1–XII–22	8	8–XII–22	7	16–XII–22	8	24–XII–22	8	
IV	23–XI–22	1–XII–22	8	8–XII–22	7	16–XII–22	8	23–XII–22	7	
	23–XI–22	1–XII–22	8	8–XII–22	7	17–XII–22	9	25–XII–22	8	2
	23–XI–22	1–XII–22	8	8–XII–22	7	16–XII–22	8	25–XII–22	9	2
	23–XI–22	2–XII–22	9	8–XII–22	6	16–XII–22	8	25–XII–22	9	2
V	23–XI–22	2–XII–22	9	9–XII–22	7	17–XII–22	8	25–XII–22	8	2
	23–XI–22	2–XII–22	9	8–XII–22	6	16–XII–22	8	24–XII–22	8	1
	23–XI–22	2–XII–22	9	9–XII–22	7	17–XII–22	8	26–XII–22	9	4
	26–XI–22	4–XII–22	8	11–XII–22	7	19–XII–22	8	27–XII–22	8	5
	26–XI–22	4–XII–22	8	12–XII–22	8	21–XII–22	9	29–XII–22	8	7
VI	26–XI–22	4–XII–22	8	11–XII–22	7	20–XII–22	9	28–XII–22	8	7
	26–XI–22	4–XII–22	8	11–XII–22	7	20–XII–22	9	29–XII–22	9	6
	26–XI–22	4–XII–22	8	11–XII–22	7	20–XII–22	9	28–XII–22	8	5
Minimum			8		6		7		7	
Maximum			9		9		9		9	
Average			8 1/2		6 23/24		8 1/6		8 1/24	

ADDENDUM

3, of THE PHILIPPINE AGRICULTURIST. It should be inserted facing page 230 of Rowan's article.

Schoenobius incertellus under laboratory conditions.

nolt.	Fourth instar.	Fifth molt.	Fifth instar.	Sixth molt.	Sixth instar.	Date pupated.	Seventh instar.	Length of larval stage.	Date emerged.	Pupal stage.	Length of immature life.	Date died.	Adult stage.	Total life history.
	days		*days*		*days*		*days*	*days*		*days*	*days*		*days*	*days*
-22	9	30–XII–22	9	12–I–23	13	22–I–23	10	64	2–II–23	11	83	5–II–23	3	86
-22	8	31–XII–22	8	12–I–23	12	21–I–23	9	63	1–II–23	11	82	5–II–23	4	86
-22	9	29–XII–22	9	10–I–23	12	21–I–23	11	64	31–I–23	10	82	4–II–23	4	86
-22	11	30–XII–22	11	11–I–23	12	20–I–23	9	65	31–I–23	11	84	4–II–23	4	88
-22	10	1–I–23	10	13–I–23	12	24–I–23	11	64	4–II–23	11	84	10–II–23	6	90
-22	8	31–XII–22	8	12–I–23	12	22–I–23	10	60	2–II–23	11	80	8–II–23	6	86
-22	9	1–I–23	9	13–I–23	12	24–I–23	11	64	3–II–23	10	83	7–II–23	4	87
-22	9	2–I–23	9	13–I–23	11	23–I–23	10	60	3–II–23	12	81	9–II–23	6	87
	9	10–I–23	9	21–I–23	11	2–II–23	12	63	13–II–23	11	83	17–II–23	4	87
	9	12–I–23	9	23–I–23	11	3–II–23	11	64	12–II–23	9	82	17–II–23	5	87
	9	11–I–23	9	21–I–23	10	31–I–23	10	61	11–II–23	11	81	16–II–23	5	86
	10	11–I–23	10	22–I–23	11	2–II–23	11	65	13–II–23	11	84	16–II–23	3	87
	9	10–I–23	9	21–I–23	11	1–II–23	11	62	12–II–23	11	81	15–II–23	3	84
	10	12–I–23	10	22–I–23	10	2–II–23	11	65	13–II–23	11	84	19–II–23	6	90
	9	11–I–23	9	21–I–23	10	2–II–23	12	64	12–II–23	10	82	16–II–23	4	86
	9	11–I–23	9	21–I–23	10	2–II–23	12	63	13–II–23	11	83	20–II–23	7	90
	9	11–I–23	9	22–I–23	11	3–II–23	12	64	14–II–23	11	84	19–II–23	5	89
	9	10–I–23	9	20–I–23	10	2–II–23	13	63	13–II–23	11	83	17–II–23	4	87
	9	13–I–23	9	23–I–23	10	4–II–23	12	64	15–II–23	11	84	19–II–23	4	88
	10	15–I–23	10	25–I–23	10	4–II–23	10	63	15–II–23	11	82	20–II–23	5	87
	9	16–I–23	9	26–I–23	10	6–II–23	11	64	17–II–23	11	83	22–II–23	5	88
	10	17–I–23	10	27–I–23	10	6–II–23	10	64	17–II–23	11	83	21–II–23	4	87
	11	15–I–23	9	25–I–23	10	5–II–23	11	66	16–II–23	11	85	19–II–23	3	88
	9	15–I–23	9	24–I–23	10	4–II–23	11	63	15–II–23	11	82	19–II–23	4	86
	8		8		10		9	60		9	80		3	84
	11		11		13		13	66		12	85		7	90
	9 7/24		9 5/24		10 7/8		10 7/8	63 5/12		10 5/6	82 17/24		4 1/2	87 5/24

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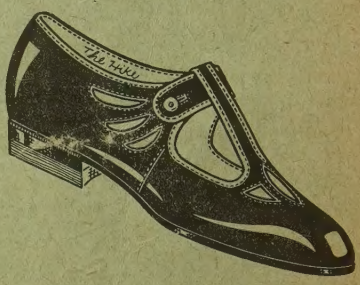

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